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ABSTRACT

Globally, knowledge of word meanings is related to reading comprehension. R. C. Anderson and P. Freebody's (1981) seminal paper on vocabulary set forth three hypotheses to explain this relationship--an "instrumentalist" hypothesis suggesting that knowledge of word meanings directly causes reading comprehension, and "general knowledge" and "general aptitude" hypotheses, which suggest that the relationships between vocabulary knowledge and comprehension are mediated by a person's aptitude or knowledge. These hypotheses are global. Beginning with the word level, under what conditions will an individual word disrupt or interfere with comprehension? Findings suggest that differences in contexts, readers, and tasks influence whether word meanings will affect comprehension. These factors are used to develop a framework for deciding if a word should be directly taught and, if it is to be taught, how extensively. (A figure is included, and 66 references are attached.) (Author/SR)

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Technical Report No. 505

BEYOND THE INSTRUMENTALIST HYPOTHESIS: SOME RELATIONSHIPS BETWEEN WORD MEANINGS AND COMPREHENSION

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Abstract

Globally, knowledge of word meanings is related to reading comprehension. Anderson and Freebody's (1981) seminal paper on vocabulary set forth three hypotheses to explain this relationship--an *instrumentalist* hypothesis suggesting that knowledge of word meanings directly causes reading comprehension, and *general knowledge* and *general aptitude* hypotheses, which suggest that the relationships between vocabulary knowledge and comprehension are mediated by a person's aptitude or knowledge. These hypotheses are global. This report begins with the word level, asking under what conditions an individual word will disrupt or interfere with comprehension. It suggests that differences in contexts, readers, and tasks influence whether word meanings will affect comprehension. It then uses these factors to develop a framework for deciding if a word should be directly taught and, if it is to be taught, how extensively.

BEYOND THE INSTRUMENTALIST HYPOTHESIS: SOME RELATIONSHIPS BETWEEN WORD MEANINGS AND COMPREHENSION

That vocabulary knowledge is strongly related to reading comprehension is among the most robust findings in the reading literature. From research in areas as diverse as readability (Dale & Chall, in press) and psychometrics (Thorndike, 1973-74), extremely strong correlations have been reported between measures of word knowledge and measures of comprehension. In a paper that had a strong influence on the resurgence of interest in vocabulary knowledge, Anderson and Freebody (1981) proposed three hypotheses to explain these correlations.

The most direct was an *instrumentalist* hypothesis, which proposes that the presence or absence of vocabulary knowledge causes or hampers reading comprehension. This hypothesis suggests that teaching word meanings would directly improve comprehension, as would mechanical substitutions of known words for unknown ones. A second hypothesis, the *general aptitude* hypothesis, suggests that vocabulary and comprehension are only indirectly related, through common links to aptitude. Vocabulary knowledge is one of the strongest predictors of overall intelligence, and intelligence relates to comprehension (Anderson & Freebody, 1981). Therefore, the vocabulary-comprehension correlations are artifacts of an ability-comprehension relationship. The third hypothesis, the *general knowledge* hypothesis, suggests a similar indirect relationship between vocabulary knowledge and comprehension, but through their common relationships to general knowledge. People who know the meanings of words like *bunt* and *shortstop* tend to know more about baseball than those who do not. People with greater topic knowledge also comprehend text better (for a review, see Anderson & Pearson, 1984).

Mezynski (1983) added one more hypothesis to Anderson and Freebody's (1981) list, the *speed-of-access* hypothesis. This hypothesis suggests that it may not be whether a person "knows" a word that is the crucial variable in the relationship between vocabulary and reading comprehension, it is how easily the word can be accessed for use in comprehension. All comprehension processes, vocabulary retrieval as well as other processes, share limited cognitive resources. Nonautomatic access to word meanings may impair other comprehension processes by consuming some of these resources that would have been otherwise available for micro- or macroprocessing, for example.

All four of these hypotheses capture some aspect of the vocabulary-comprehension relationship. The aptitude hypothesis gets support from the strong correlations between general vocabulary and general intelligence and reading comprehension. O'Brien (1986) and Stahl, Hare, Sinatra, and Gregory (1990) both found a measure of general vocabulary to be a better predictor of passage comprehension than knowledge of vocabulary specific to the passage. This suggests that it is more than knowledge of specific words that affects comprehension. Yet, as will be discussed later, the connections between aptitude and vocabulary may not be as clear-cut as they appear.

The general knowledge hypothesis has not fared as well. The basic premise that passages will contain vocabulary specific to their topic and these words will be better known by people with greater topic knowledge is unassailable. But in general, vocabulary and prior knowledge seem to function separately. Freebody and Anderson (1983b), Stahl and Jacobson (1986), Stahl, Jacobson, Davis, and Davis (1989), and Stahl, Hare, Sinatra, and Gregory (1990) all found that vocabulary knowledge and prior knowledge had specific effects on comprehension, but that these effects did not interact with each other.

The speed-of-access hypothesis has also received support. Beck, Perfetti, and McKeown (1982) found that, as a result of instruction, children could access the meanings of words they had been taught faster than words they had not been taught, suggesting that students learned the words well enough so that the words were available for complex processing tasks. Word frequency, which presumably measures how often children encounter words in text, also has strong relationships with timed recognition measures, both of reaction time measures involving isolated word recognition and with fixation duration during reading (Just & Carpenter, 1987; Nagy, Anderson, Schommer, Scott, & Stallman, 1989). These findings suggest that as readers encounter a word over and over, it becomes easier for them to access the word's meaning. Presumably faster lexical access aids comprehension or, at least, does not impede it.

The Instrumentalist hypothesis. As an educator, I have been most interested in the instrumentalist hypothesis, because it, or variations of it, suggests that one can improve comprehension by teaching words. This hypothesis has received support from both well-designed research studies such as those of Beck, McKeown, and their colleagues (Beck, Perfetti, & McKeown, 1982; McKeown, Beck, Omanson, & Perfetti, 1983; McKeown, Beck, Omanson, & Pople, 1985); Kameenui, Carnine, and Freschi (1982); and Stahl (1983), among many others, and from research syntheses, such as the meta-analytic review conducted by Stahl and Fairbanks (1986). Stahl and Fairbanks, for example, found that some forms of direct instruction of word meanings had a significant effect on the comprehension of passages containing taught words and on comprehension in general. They found that a child at the 50th percentile in a group that was pretaught word meanings performed as well as a child in the 82nd percentile of the control group on measures of comprehension of passages containing taught words and as well as a child at the 63rd percentile on standardized measures of comprehension not necessarily containing taught words.

Not all vocabulary instruction improved comprehension, however. Instead, Stahl and Fairbanks suggest that for vocabulary instruction to have a significant effect on comprehension, it needed (a) to include both definitional and contextual information about to-be-learned words, (b) to involve students in active, meaningful processing of the words and their meanings, and (c) to provide multiple exposures to meaningful information about each word. This means that relatively complex treatments appear to be needed for vocabulary instruction to improve comprehension. Simply drilling children on definitions or having them look up words in dictionaries had little or no effect.

However, there are powerful arguments against an instrumentalist hypothesis in its strongest forms, or, at least, against the implication derived from the instrumentalist hypothesis that direct instruction of word meanings will necessarily improve comprehension. One arises from Nagy and Anderson's (1984) finding that printed school English contains 88,700 discrete word families. If children learn about half of these over the school years, and if they enter school with about 6,000 words already known (and these seem to be supportable assumptions), then they would be learning an average of 3,000 words per year. Because this is far more words than could be taught through direct instruction, the vast majority of these words must be learned by children in the context of reading. The 300 to 400 or so words that reasonably could be taught to children through direct instruction might add a significant amount of new word meanings to those already being acquired through context, especially for poorer readers who learn considerably fewer than 3,000 new words per year. But direct instruction, at least not instruction as extensive as appears to be needed in order to be effective, cannot logically account for the majority of word learning.

Thus, vocabulary instruction can significantly improve comprehension but cannot account for all of the words ordinarily learned. The vocabulary instruction that appears successful, given our current research designs, is very extensive and time consuming. However, as I will discuss throughout this report, extensive instruction may not be needed for all words in all situations. What is needed is a means for teachers to better estimate when words need extensive instruction and when less extensive instruction would be equally useful.

Changing Perspectives

Another problem with the body of instructional research is in the measures used in it to assess comprehension. In the majority of the studies that found an effect on comprehension for rich and elaborate vocabulary instruction (e.g., Beck et al., 1983; McKeown et al., 1983, 1985; Kameenui, Carnine, & Freschi, 1982; Stahl, 1983), the criterion passages contained a high percentage of unknown words, typically 10% or higher. In many of the studies that failed to find such an effect, the percentage of taught words was much lower (e.g. Ahlfors, 1979). Yet, as I mentioned earlier, a reader typically encounters between one and a half and three unknown words per hundred running words, a considerably smaller percentage than used in these studies. Large percentages of unknown words were used to simulate the effects of long-term vocabulary instruction, after which, presumably, larger percentages of words would be taught.

To understand the effects of these larger percentages on comprehension, one must understand how an unknown or partially known word affects comprehension. This involves looking at the vocabulary-comprehension relationship from a different perspective, that of the individual word's effect on understanding the individual passage. From this perspective, all four vocabulary-comprehension hypotheses seem too general. Each examines the overall effect of knowing word meanings (in general) on comprehending passages (again, in general). Each loses important distinctions about word knowledge, such as how well a person knows a word, or the types of knowledge a person has about particular words. Each also loses distinctions about reading comprehension, such as the type of task used to measure comprehension.

In real-world comprehension, a person rarely approaches a task with a total absence of knowledge about a word. In fact, it took me a great deal of reading to come up with the passages below and with *micturition* and *minatory* as examples of words that I--and perhaps the reader of this report--did not know. I chose two passages of roughly 75 words each for my examples because for a school-age child, experiencing one unknown word per 75 words is typical. Therefore, the experience of a well-educated reader reading these passages should be analogous to that of a typical school-age child reading appropriate materials. In addition, a person having no comprehension of what he or she has read is also rare. Instead, a reader will get some information about a text's meaning, no matter how difficult the text might be. Consider then, these passages and how the two italicized words affect your comprehension.

> "Oh, all right," I grumbled. I turned off the water and went into the living room to do my stretches. Peppy didn't understand why I wasn't limber and ready to go as soon as I got out of bed. Every few minutes she'd give a *minatory* bark from the back. When I finally appeared in my sweats and running shoes, she raced down the stairs, turning at every half landing to make sure I was still coming. (Paretsky, *Blood Shot*, 1988, p. 28)

> Then I am in the short passage leading to the kitchen at the rear. I find the men's room door. I am hit by the salt stink of a public bathroom. Mr. Schultz stands at the urinal with his legs apart and his hands on his hips so that the back of the jacket wings out, and his water arcs from him directly into the urinal drain, thus making the rich foaming sound of a proud man at his *micturition*. (Doctorow, *Billy Bathgate*, 1989, p. 300)

If you are like me, you had not seen either *micturition* or *minatory* before reading these passages. Yet, in neither case did you have difficulty understanding what you were reading, and, indeed, you might not have taken notice of either word had you been reading it in the original book rather than in a paper on word meanings.

Although it is clear that one unknown word in a short passage will not cause comprehension breakdown, it is not clear exactly what effects an unknown word might have. Larger models of reading appear to focus on either word recognition processes (such as Adams, 1990) or comprehension processes (such as Kintsch & van Dijk, 1978). Vocabulary knowledge is somewhere between these two perspectives, so we must look at both to understand the role of word meanings in comprehension. To examine the role of partial word knowledge in comprehension, I will first look at lexical knowledge from a bottom-up view, focusing on the interactions between orthographic and contextual knowledge in comprehending and in learning word meanings. Then I will shift the focus to look at the effects of unknown words on comprehension of larger units of text. Finally, I will speculate about what implications the role of word knowledge has for instruction and for the other three hypotheses.

Word Meanings, Orthography, and Context

The model of word recognition illustrated in Figure 1 is taken from Adams (1990), but most interactive models of reading (e.g. Just & Carpenter, 1987) make similar predictions. Adams proposes that four interconnected processors act upon written words. The orthographic processor contains our knowledge of spelling patterns and uses that knowledge to identify words. The phonological processor contains parallel information concerning our knowledge of sounds in spoken words. The meaning processor contains information about word meanings and

how they relate to each other. The context processor contains our ongoing information about the text, derived from our comprehension.

[Insert Figure 1 about here.]

In this model, visual information from the printed page first goes to the orthographic processor, which takes the information available from visual perception and matches it with a reader's knowledge of spelling patterns. While doing this, it receives and shares information with the phonological and meaning processors. The phonological processor reinforces information directly available from orthography, as well as information incoming from the meaning processor. The meaning processor contains our store of word meanings, which takes and provides information to the orthographic processor about possible word meanings. The context processor, in turn, takes and provides information to the meaning processor, allowing the meaning processor to choose among alternatives.

It is the meaning processor that concerns us most, because this is where the vocabulary store is acted upon. Adams (1990) views the meaning processor as an interconnected network of concepts, similar to the semantic networks proposed by Collins and Loftus (1975). Network models have their proponents and detractors (see Smith & Medin, 1984). For the purpose of this report, however, the exact format of the storage is not important. What is important are the interconnections between this processor and other processors. In the model shown, the meaning processor gives and receives information from two other processors, the context processor and the orthographic processor. The context processor is where Adams (1990) suggests that ongoing processing of sentences occurs. She suggests that as comprehension (begging, for the moment, the question of exactly what comprehension is) occurs, information available from context is available for the meaning processor to help decide the meaning of an unknown word.

Learning from Context and Comprehension.

In Adams's model, if a word is totally unknown, as *micturition* and *minatory* were to me, the meaning processor would have no information available to activate. The meaning processor would simultaneously get stimulation from both the orthographic processor and the phonological processor, providing information about the word's spelling and pronunciation, and the context processor, providing information about ongoing comprehension. Within the orthographic processor, some sort of representation of *micturition* would be formed, involving the reinforcement of links between already represented spelling patterns. This would be available the next time the word is encountered.

The two contexts presented earlier differ significantly in the richness of information provided about these two unknown words. For *minatory*, the context simply does not provide any relevant support for a reader to infer that *minatory* means "threatening." Yet, as I stated earlier, the word should cause little comprehension difficulty. The main point of the paragraph in which the word appears is that the unnamed first person is preparing to take her dog for a walk. The only portion of the message that would be missed relates to the nuance of the dog's bark. The point of the sentence, that the dog is communicating her impatience, is available from context, which provides the nuance of how that impatience is conveyed.

In the case of *micturition*, if the context were completely comprehended, the information from the context processor would include information about bathrooms, that the use of a urinal was involved, and so forth. This would suggest strongly that micturition relates to urination (which, in fact, it does). But the reader probably would not stop and substitute *urination* for *micturition*. Instead, *micturition* would be tied (weakly, since this is only the first encounter) to roughly the same concepts as *urination* might be. Probably, both *micturition* and *urination* might be accessible from the same concepts (although *micturition* would be harder to access because of the weakness of the links), but *urination* and *micturition* would not be *directly linked* but connected only through their *common linkages*. Omanson, Beck, McKeown, and Perfetti (1984) found that readers are more likely to process incompletely a proposition containing an unknown word than to substitute a synonym for that

word and continue normal processing. Thus the information about *micturition* would be tied weakly to orthographic representation and be available for the next encounter with the word.

Studies of children's derivations of word meanings from context, in which subjects are given sentences containing nonce words and are asked to give tentative definitions for words after each new sentence, suggest that, at first, children tend to integrate thoroughly the word's meaning with the context in which it appears (Elshout-Mohr & van Daalen-Kapteijns, 1987; McKeown, 1985). Children with high verbal ability begin to decontextualize the word's meaning, drawing elements from different exposures together to create a flexible representation of the word's meaning (see also Nelson & Nelson, 1978). Children with low verbal ability tend either to create a new meaning from each context, not integrating meanings across contexts, or tend not to distinguish well between information that overlaps between contexts and information that does not. McKeown (1985) noted that low-ability students may carry the topic of one sentence to the other sentence, rather than isolating the portions of word meaning common to both.

It is probably not desirable to substitute a synonym for words encountered in context in real-world comprehension. Often contexts contain misleading information about the word's meaning, information that may interfere with comprehension the next time the word is encountered. If, on a first encounter, a reader wrongly associates one word with another, this misassociation might interfere not only with ongoing comprehension but it might also interfere with comprehension the next time the reader encounters the word. Consider what word you might substitute for *minatory* in the sentence provided earlier. In my informal survey of adults, "threatening" was never offered as a potential meaning for minatory. Let's say a reader infers logically from the context of the sentence that minatory means "short." However, the second time the reader encounters minatory is in the sentence "He gave her a minatory glance." In this case, the use of minatory is meant to suggest that the "he" is contemplating villainy. Substituting "short," although it would yield a plausible meaning, would nonetheless cause the reader to lose the nuance of this second sentence. Contexts are misleading a good proportion of the time, and without recourse to a dictionary the reader does not really know whether the initial encounter or the second encounter or both was misleading. So it is not usually a wise strategy for a reader to commit to any particular synonym for an unknown word encountered in context.

Differences in Contexts

The Effects of Overlap

Because the information in the case of *micturition* from the context processor strongly overlaps with the actual, intended meaning of the word, the presence of an unknown word here is not likely to impair comprehension markedly. This is not always the case. Context can be more or less congruent with a word's meaning. When the meaning of the word is not congruent with that expected from the context, subjects have difficulty using the context effectively to learn the meaning of the unknown word. In the *minatory* passage, as in the passages studied by Shatz and Baldwin (1986) and Beck, McKeown, and McCaslin (1983), the meaning of the word was not easily discerned from context.

If the information available from context overlaps strongly with the intended meaning, it is more likely that a person will learn the meaning of that word from context. In a series of studies, Nagy and his colleagues (see Nagy, Anderson, & Herman, 1987, for example) found that the congruence of the context with the tested meaning of the word influences the likelihood of learning an individual word from context, as did a number of factors, including the conceptual difficulty of the word. Thus a naive reader, reading both *Billy Bathgate* and *Blood Shot*, would be more likely to learn the meaning of micturition than minatory.

If there is a strong overlap between the information and the meaning of the word, it also is less likely that particular word will disrupt comprehension, or, if it does, that it will do so in a different manner than will a word with less overlap. When an unknown word is encountered, the process of searching for its meaning will take some time, time that may or may not interfere with comprehension, depending on the demands of the rest of

the task. But if the information about the word is incongruous, it might send the reader down a garden path, which either will lead to a breakdown of comprehension or require resource-consuming repairs.

Some evidence for this notion comes from the effects of revisions that make text more "considerate," or the context more congruent with the word's intended meaning. Herman, Anderson, Pearson, and Nagy (1987), Konopak et al. (1987), and Konopak (1988) found that such revisions improved both comprehension and learning words from context. Such revisions include apposition of an explicit definition, clearly signaling relations between target words and other words in the passage, or elaborated explanations placed around the target word. As will be discussed below, many readers cannot take advantage of such elaborations when they are provided. In natural language, however, such appositions and elaborations are rarely provided because words are chosen for their appropriateness to the topic, and authors do not ordinarily feel they have to define them.

Richness of Information

Related to the issue of overlap is the richness of the information provided by contexts. Some contexts will use a word in passing; others, such as the micturition passage, will provide a great deal of information around that word. If one assumes, as Adams (1990) does, that information about word meanings is stored as part of a network of interrelations between concepts, then the richer or more elaborate the information provided about the word's meaning, the more likely it is that the word will be recalled and used. With richer contexts, it is also less likely that an unknown word will interfere with comprehension.

A word like *minatory*, if encountered only in the one context presented earlier, might be only known as a type of bark. *Micturition*, on the other hand, may be accessible from a number of related concepts, including *bathroom*, *urinal*, *Dutch Schultz* (the referent of "he" in the passage), and so forth.

Each connection from one exposure would be weak, and, in the model described by Adams (1990), weak connections are more difficult to access. Even with weak connections, a reader having a multiplicity of such connections would be more likely to access a word's meaning than a reader with fewer equally weak connections (Just & Carpenter, 1987). Thus, even with a single exposure, a word encountered in a richer context is more likely to be learned than is one encountered in a less-rich context, as was indeed found by Herman, Anderson, Pearson, and Nagy (1987).

Together the amount of overlap between the word and the context and the richness of the context produce two complementary effects. First, a word in a rich and congruent context is less likely to impair comprehension than a word in a less-rich or less-congruent context. Second, a word in a rich and congruent context is more likely to be learned from that context.

Taxonomies of context cues. One approach to describing many of these variations has been the use of taxonomies of context cues. A number of such taxonomies have been developed largely to teach the use of context to children. However, the evidence is scant that teaching children taxonomies of context cues improves their ability to derive word meanings from context (see Graves, 1986). Such taxonomies may be useful in helping them describe richness of contextual support. Sternberg and Powell (1983) have developed a model of learning from context that suggests that variation in learning from context is due to three factors--(a) processes of knowledge acquisition, (b) contextual cues in the text, and (c) moderating variables. Processes of knowledge acquisition include selective encoding, selective combination, and selective comparison. Individual variations in these abilities are expected to underlie differences in learning word meanings. Contextual cues, such as temporal cues, spatial cues, and so forth refer to the information given in the text about the target word. Presumably the more different types of cues given, the easier the word is to learn, all other factors being equal. Moderating variables include the number of occurrences of the unknown word, the variability of contexts containing the unknown word, the importance of the unknown word to understanding the context, the helpfulness of the context surrounding the unknown word, the density of unknown words, and the usefulness of previously known information.

Directiveness of contexts. The taxonomy of Sternberg and Powell (1983) was developed for teaching students to better utilize context. The more intuitive approach of Beck, McKeown, and McCaslin (1983) might be better suited for helping teachers make decisions about the need for instruction of words in context. They defined four general types of contexts, *directive*, or contexts that direct a highly specific meaning for an unknown word; *general directive*, or contexts that suggest a general meaning, *nondirective* or neutral contexts; and *misdirective*, or contexts that may mislead a reader about a word's meaning. Of the two passages used in this report, the context in the minatory passage would be classified as misdirective and the context in the micturition passage would be directive.

Beck, McKeown, and McCaslin's (1983) approach mixes the factors of overlap and richness discussed earlier. In general, a directive context is going to have a high degree of overlap between a word's meaning and a rich context. A misdirective context, on the other hand, will generally have a low overlap in a rich context. It is the richness of the context that strongly suggests an incorrect meaning. Following the same analysis, a generally directive context would have a strong overlap in a sparse context and a nondirective context would be low in both richness and overlap. The bipolar dimensions of richness and overlap seem to have more heuristic value, but the scale of Beck et al. (1983) may be as useful for making instructional decisions. All other factors being equal, one might elect to teach a word in a nondirective or misdirective context before teaching one in a directive or even generally directive one. The other factors, which may or may not be equal, include the importance of the unknown word, as well as differences in the abilities of students.

Importance of the Unknown Word

The amount of information a reader gets about a word's meaning may also relate to the word's importance to the passage as a whole. Importance may affect learning from context in at least two ways. First, a reader may devote more attention to learning an unknown word if it is an obstacle to understanding an important concept than if it is relatively unimportant.

Second, as in the case of *micturition*, the word relates directly to the *major* idea of the chapter from which it was taken, that Dutch Schultz was shot while in the bathroom. The details in the passage elaborate that macrostatement, and thus elaborate micturition. If a word is located in a proposition relatively lower in importance, fewer words in the passage will elaborate on that proposition, and thus the person will receive less information about the new word. Because the information provided is less elaborate, the word is less likely to be learned. In the two context examples used in this paper, in the micturition example, the word was tied to ideas important to the meaning of the entire passage; in the minatory example, the unknown word was relatively incidental.

Summary of Differences Between Texts

There seem to be three significant differences among texts that affect both learning from context and comprehension--(a) the overlap between the information in the context and the word's meaning, (b) the richness of information available in the context, and (c) the importance of the word in relation to the rest of the passage. These factors all have complementary effects on learning from context and comprehension. As it becomes more likely that a word will be learned from context--through a greater overlap of information, richer contexts, or because the proposition that the word is attached to is more important--that word is also less likely to affect comprehension.

For making decisions about instruction, the more important a word is to the content, the more important it would seem to be to teach explicitly the word's meaning. The greater the overlap between the word's meaning and the information available from context and the richer that information is, or the more directive the context is, the less extensive that instruction needs to be. If a word's meaning is adequately directed from the context, discussion of a definition may be enough. If the meaning is not accessible from context, more extensive instruction may be needed.

This is true only for words that represent concepts already in a reader's concept store. For words representing concepts new to the reader, extensive instruction will always be required. Polysemy and homonymy will also affect instructional decisions. The presence or absence of prefixes, suffixes, and roots are also important distinctions among words, but morphology will not be discussed in this paper.

Differences Among Words

Conceptual Complexity

It would seem that unknown words representing concepts new to the reader would create different problems than words representing known concepts. Information from a single context could not adequately describe a complex concept that a student does not know prior to reading. Thus, a student might be less likely to learn from context a word like *osmosis* than a word like *pusillanimous*. This is especially a problem in content area textbooks, in which complex concepts are often defined with an appositive, such as:

The colonists wanted their *independence*, or freedom, from another's power.
If a student did not know the meaning of *independence*, such a context would not be adequate to learn it. Indeed, Nagy, Anderson, and Herman (1987) found that conceptual difficulty strongly affected the probability of learning a word from context, and that there "was simply no learning from context for words at the highest level of conceptual difficulty" (p. 255).

Instead, students might need to develop conceptually complex words through more elaborate use of examples, non-examples, superordinates, and so forth, so that they develop a flexible understanding of a concept and its boundaries (see Frayer, Fredrick, & Klausmeier, 1969).

One might similarly assume that unknown words at a high level of conceptual difficulty would more strongly affect comprehension, because they would be more likely to carry a higher percentage of the content of the passage than less conceptually complex words. However, conceptually difficult words would also be more closely tied to the topic of the passage. A person's knowledge of conceptually difficult words might reflect his or her knowledge of the domain from which the word comes.

Polysemy and Homonymy

Two related concepts useful for examining the effects of unknown words on comprehension are polysemy and homonymy. Polysemous words are words that are orthographically identical but share related, although separate meanings. An example would be *line* as in "to get in line" or a "line of Kings." Both uses are derived from the core meaning, that of a line such as this: ----------. (Sometimes, a picture indeed is worth a thousand words.) Homonyms share the same spelling but different meanings with different derivations, as in *line*, meaning to "line one's pockets." In this case, *line* is derived from *linen*, not a straight line.

One could write passages containing enough polysemous words and homonyms so that they were completely ambiguous (for an example, see Anderson & Pearson, 1984), but in the ordinary case, it is unclear whether polysemy or homonymy creates genuine comprehension difficulties. Context could (and certainly does) disambiguate polysemous words. In fact, Anderson and Nagy (in press) have argued that all words are polysemous, because their meanings change in every unique context in which they appear. If so, some amount of acceptance of polysemy would be part of ordinary processing of word meanings. However, reports from non-native speakers of English suggest that polysemy can create specific problems (Imai, personal communication, December 1989).

Differences Between Readers

In addition to differences among texts and among words, there are a number of differences between readers that affect both learning from context and comprehension. Differences in the amount of prior vocabulary knowledge

certainly affects both word learning and comprehension. Such differences may affect children's ability to comprehend the information in the context that supports the unknown word's meaning. Differences in topic knowledge as well as differences in ability and in working memory have been discussed in the literature as well.

Differences in Prior Word Knowledge

Children with low vocabulary knowledge may not gain the same benefits from context as children with high vocabulary knowledge. For such children, even explicit definitions used as appositives, the most directive of contexts, may not be useful if they do not know the meanings of the definitions themselves. Because children with low vocabulary knowledge tend not to know a great many words, including some that are used to define other words, they might not be as able to take advantage of such definitions. For example, Shefelbine (1990) found some low-ability students misunderstood *gaucho* in the sentence, "Gauchos, the cowhands of South America, learned to chase the birds on cow ponies."

> One student, who did not know the meaning of "cowhand" on the pretest, incorrectly inferred from the passage that they were Indians who hunted rheas. . . . The same student then used his understanding of cowhands to define "gauchos" as "cowhands, a type of Indian." A second student who thought cowhands were ponies, concluded that gauchos were "cow ponies, ponies to chase birds." In four other instances, inappropriate responses for cowhands were used to define gauchos. One of the more inventive, but still logical interpretations saw cowhands as being the front feet of a cow." (p. 90)

Even for better readers, definitions might be misunderstood. Miller and Gildea (1987) asked children to make sentences for unknown words from definitions and found that these sentences often showed serious misunderstandings of the sentences. For example, for the following definition of *redress*:

> 1. set right; repair; remedy: *when King Arthur tried to redress wrongs in his kingdom.*

One student wrote,

> The *redress* for getting well (when) you're sick is to stay in bed.

As discussed earlier, the more explicit the information that contexts provide about a word's meaning, the more likely the word is to be learned *and* the less likely that it will disrupt comprehension. Yet even the most explicit contexts, when definitions are put in apposition, will not aid comprehension for students who do not understand the defining terms and/or do not flexibly apply the information from varied sources to gain a more accurate representation of the word's meaning and to aid ongoing comprehension.

In general, students must be able to use the elaborated contexts to make sense of the unknown words. In the case of *redress*, a student focused on a "sickness" instantiation of *remedy*, rather than on the broader meaning. The student may have had only partial knowledge of *remedy*, and this partial knowledge may have interfered with the learning of *redress* (see McKeown, in press; Scott & Nagy, 1990).

Children who know more word meanings also tend to read more than do children with lower vocabulary knowledge (for review, see Stanovich, 1986). More exposure to text translates into exposure to more words, meaning more partial and full meanings of words are available. Thus, in Stanovich's terms, "the richer get richer," and children who know more, learn more, exacerbating the differences between high- and low-verbal children over time.

Can vocabulary instruction reduce these differences? Possibly, possibly not. On one hand, vocabulary instruction may account for a larger percentage of words that children with low vocabularies learn over the course of the school year. Estimates of the number of words a child ordinarily will learn from context range from 1,000 to

5,000 new words (Graves, 1986). For a child at the low end of this range, the 300 to 400 words taught through direct instruction will be more significant than for a child at the upper end.

On the other hand, children with low vocabulary knowledge are in a double bind. Because they are less likely to know words in the context, making contexts less useful, they may need more intensive instruction to learn each new word. More intensive instruction is going to take time away from other activities, including the wide reading that will not only better allow them to solidify their vocabulary gains but also will itself lead to greater vocabulary growth.

Differences in Topic Knowledge

One might also assume that greater topic knowledge would enable students to be more efficient at learning from context. Two studies that examined this question, Barnes, Ginther, and Cochran (1989) and Stahl (1989), failed to find clear effects of prior topic knowledge on learning word meanings from context. These studies both manipulated prior knowledge through some form of preteaching. While such manipulations seem to affect comprehension (e.g., Stahl & Jacobson, 1986), a better test of the effects of prior knowledge on learning word meanings might be to examine preexisting prior knowledge. Herman et al. (1987) did find a significant effect for subjects' reported prior knowledge on learning from context.

Greater prior knowledge may affect learning from context in three ways. First, readers with more prior topic knowledge may be able to devote more available resources to examining unknown words, because they presumably will have less difficulty connecting information in the text to an already existing knowledge base (Anderson & Pearson, 1984). Second, readers with more prior knowledge would be more likely to understand the information elaborating the unknown word and thus be able to get greater benefit from context. Third, readers with more prior knowledge would be more likely to have partial knowledge of the unknown word. This may be the case in the Herman et al. (1987) study, because the words tested tended to be related to the topic, such as *pulmonary*, *circulatory*, *artery*, and *capillary* for the topic "Circulation" and *levee*, *runoff*, *tributary*, and *turbulent* for the topic "River Systems." Shore, Durso, Dayton, Coggins, Davis, Beasley, and Gloria (1987) found that adults could learn words for which they had partial knowledge faster than words for which they lacked such knowledge. In the case of the Herman et al. (1987) study, the context may have served to add enough information to already existing word knowledge of subjects with high topic knowledge. Subjects with low topic knowledge, lacking that partial knowledge, needed more exposure to both words and topic to learn them.

Therefore, topic knowledge might influence word learning to the extent that the to-be-learned words are tied to the topic. Words like *circulatory*, *tributary*, and so forth, which are closely tied to a specific topic, would seem to be influenced more by topic knowledge. This could be because persons having prior knowledge of the topic might have had some exposure to the target words. Or it could be that persons with greater topic knowledge have a richer existing conceptual store to tie the words to as they are encountered. Words that are more general, or that can appear in texts dealing with a number of different topics, may not be related to topic knowledge at all.

Differences in Ability

A number of different studies have examined the relationship between readers' ability and learning word meanings from context. Here the results seem to form a consistent pattern. Studies in which children were asked to *derive* word meanings, that is, studies in which children were told prior to reading that they were expected to come up with a definition of a word they were to read in context, have found clear differences between students of high and low verbal ability in deriving word meanings from context (see Elshout-Mohr & van Daalen-Kapteijns, 1987; McKeown, 1985). Of studies examining *incidental* vocabulary learning, or studies in which students were not told that they would be tested on words they read in context, the majority of studies did not find such ability differences (for review, see Stahl, 1989).

Even though this pattern seems clear, its interpretation is not. First is the question of whether the derivation task or the incidental task is more appropriate. The incidental task seems to mirror what presumably happens "naturally." The derivation task may be inherently more susceptible to ability effects since studies which have used it, such as McKeown (1985) and Elshout-Mohr and van Daalens-Kapteijns (1987) have used constructing a definition as their criterion measure. Such a measure may require more verbal ability than a multiple choice test. In addition, as noted above, it seems likely that readers do not ordinarily derive a synonym for words encountered in context, but instead might recall the associations between the word and information in the context. Thus, the derivation task may add an extra layer of complexity. This layer may account for the strong individual differences found.

But the question should be kept open, if for no other reason than the impossibility of accepting a null hypothesis. In addition, of the incidental learning studies, Herman, Anderson, Pearson, and Nagy (1987) did find significant ability differences in learning words from context.

This question, if left open, leads to other interesting questions. If ability does, in fact, influence learning word meanings from context, does it mean that one should train directly the ability to derive word meanings from context, as suggested by Sternberg and Powell (1983)? The results of such training have been ambiguous at best, with relatively few studies finding that training children in context cues affects word learning (see Graves, 1986 for review). If ability does not directly affect learning from context, then are the differences in word knowledge due to differences in the amount of reading done by good and poor readers rather than ability, as suggested by Stanovich (1986)?

One final point: It is also not clear how much verbal ability influences word learning and how much of it is influenced by word knowledge. Verbal ability is partially measured by measures of vocabulary knowledge (or measures strongly correlated to them, such as reading comprehension measures), so it is possible that differences in verbal ability merely represent differences in breadth or depth of a student's vocabulary knowledge. A student with broader or deeper vocabulary knowledge might know more about the words in a defining context, even if a nonce word were the target word, as in the McKeown (1985) and Elshout-Mohr and van Daalen-Kapteijns (1987) studies. In Shefelbine's (1990) study, in which a non-verbal measure was used to measure ability, no relationships were found between ability and intentional learning of word meanings from context.

Working Memory

Yet another difference in readers that might affect learning from context may be differences in working memory capacity. Working memory is defined in terms of both memory capacity and processing ability. This has been measured in a number of studies by a reading span test, in which subjects read increasingly longer sets of sentences and are asked to recall the last word of each sentence (Just & Carpenter, 1987). Presumably, people with longer reading spans can hold larger proportions of text in working memory, and thus have more information from larger contexts available for learning a word's meaning. Daneman (1988) has found that learning from context has a moderately high correlations with differences in working memory, (r = .66), higher than correlations with age or grade. She suggests that differences in working memory, which appear to develop with age, may underlie developmental differences in efficiency of learning from context, such as those found by Werner and Kaplan (1952).

It is, however, unclear exactly what the reading span test is measuring. Because it includes both capacity and processing in its definition, differences in reading span may reflect no more than differences in basic verbal ability, which brings us back to the problems discussed above.

Summary of Differences Among Readers

In short, children who know more words can learn more words. They can do this for two reasons. First, they are more likely to know the meanings of the words in the context, and thus get richer contextual information about each unknown word. A child who has low vocabulary knowledge to begin with may not be able to take

full advantage of a rich and elaborated context. Second, children who know more words are likely to read more, and reading more means that they are exposed to more words.

The effects of differences in topic knowledge, verbal ability, and working memory are less clear. Topic knowledge might affect words closely related to the topic, but it is not clear whether topic knowledge itself aids in learning new words or merely reflects prior exposure to targeted words. Verbal ability seems to affect children's ability to derive word meanings, but not their ability to learn them incidentally from text, but whether the incidental or derivation tasks are better measures of word learning is not clear. It is equally unclear whether measures of working memory reflect something different from verbal ability.

As a Word Is Learned

Up to now, we have discussed the effects of various factors on one exposure to a word in context. With additional exposures, a richer understanding of the word's meaning is obtained. This happens two ways. First, there is nearly always an overlap between information received from different exposures. It would seem that the greater the overlap between exposures (and presumably the greater the overlap in each exposure between the context and the intended meaning), the more likely the word is to be learned. The repeated exposures to this overlapped information would strengthen it, making it the core of the word's meaning. The stronger the association, the easier it is to access it once the orthographic representation of the concept is activated (Just & Carpenter, 1987). These areas of overlap would also become the default interpretation, or how the reader evokes the concept in the absence of constraining context, as will be discussed below. Second, broader contextual information would increase the number of links to other concepts, making the word easier to access. Beck, Perfetti, and McKeown (1982) found that increased amount of practice during vocabulary instruction led to faster access. Words that received the most practice were responded to on semantic decision tasks as rapidly as were common words, but words receiving less practice were responded to significantly slower. There were no differences in accuracy between the two types of words. On sentence decision tasks, the results were similar. Thus, it seems that even once accuracy is achieved, increased practice with words can lead to gains in speed of access. (McKeown, Beck, Omanson, and Pople [1985] found that, beyond a certain limit, increased numbers of exposures in vocabulary instruction did not improve speed of access, suggesting that there is a ceiling to this effect.)

Access speed and comprehension. Whether these increases in access speed necessarily lead to improved comprehension is unclear, however. First, as discussed earlier, word frequency is strongly related to a variety of reaction time measures. And word frequency (or more precisely, word family frequency) appears to be related to passage comprehension (Ryder, 1989). Evidence for this relation has also been found in instructional studies, but here the evidence is less consistent. Beck, Perfetti, and McKeown (1982) and McKeown, Beck, Omanson, and Pople (1985) found differences in effects for words receiving more and those receiving less practice on some measures of comprehension, but not others.

However, a large number of exposures may not be sufficient for a reader to access efficiently a word's meaning if the exposures contain limited information. In a series of studies, Jenkins and his colleagues (Jenkins, Pany, & Schreck, 1978; Pany & Jenkins, 1977) found that drilling children on the connection between a word and its synonym (For example, "debris means trash") was very effective in getting children to recall the synonym, but did not affect comprehension. In this case, children received a great deal of practice making a single connection between a new word and already known information. To be useful for comprehension of text, to-be-learned words seem to need a number of different connections to known words and concepts. In her review of the effects of vocabulary instructional methods on comprehension, Mezynski (1983) found that those methods that did improve comprehension all taught words in rich and varied contexts. Often these successful methods provided fewer exposures than the unsuccessful methods such as those used by Jenkins and colleagues.

The effects of access speed would seem to vary depending on two dimensions of the text -- percentage of difficult words and difficulty of the comprehension task in general. Slowness in accessing one word might not interfere with comprehension. Slow access to a great many words would slow comprehension down in general, leading

to loss of information. Because all processes must compete with each other for limited cognitive resources, excessive difficulty with accessing word meanings would consume resources ordinarily used by other processes.

Also, as the comprehension task itself becomes more difficult, either because the topic is unfamiliar and the reader has to construct new knowledge structures or because the task demands are themselves high or because the passage is poorly or ambiguously written, the presence of known but difficult to access words is likely to affect comprehension to a greater extent. This is also likely specifically to affect development of a microstructure, because this may be more resource intensive.

Vocabulary Knowledge and Comprehension

To this point, I have discussed operation of the context processor rather generally, without specifying the mechanisms with which it works. For the arguments above, it was necessary simply to understand that the context contributes information about a word's meaning and that information becomes easier to access again if matched with information already in the meaning processor.

The information from context also appears to choose which information about a word's meaning is salient. For example, for the sentence "Nurses have to be licensed," the context highlights the "medical professional" aspects of the concept *nurse*. For the sentence, "Nurses are often beautiful," the context highlights that *nurses* are often female and young. Anderson, Pichert, Goetz, Schallert, Stevens, and Trollip (1976) found that the word "doctor" was a better retrieval cue for the first sentence than for the second, while the reverse was true for the word *actress*. They suggest that each context causes a particular instantiation for each word (see also Anderson & Nagy, in press). This instantiation consists of the information about the word salient to the context, which in turn, feeds back into the context processor, adding to information about the context, and thus aiding continuing comprehension. The same process may resolve ambiguities about polysemous words, as discussed above.

Thus, the richness of information available from the context may lead to a more precise instantiation of each word, and thus to richer information available in the context processor to instantiate the next word.

Microprocessing and Macroprocessing

The ongoing sentence comprehension represented by the contextual processor of Adams (1990) has at least two components, microprocessing and macroprocessing. Microprocessing involves the combination of individual words into propositions and propositions into a coherent representation of the text, or a microstructure. Macroprocessing involves the development of a gist representation of the content of the text. In a number of models (e.g. Kintsch & van Dijk, 1978; Just & Carpenter, 1987), the reader strategically applies reduction strategies to the developing microstructure to develop the macrostructure, in interaction with schema-driven macroprocesses. Our research (Stahl & Jacobson, 1986; Stahl, Jacobson, Davis & Davis, 1989; Stahl, Hare, Sinatra, & Gregory, 1990) and that of others (Freebody & Anderson, 1983b; Ryder, 1989) suggests that vocabulary difficulty has its greatest effect on microprocessing, while prior topic knowledge affects macroprocessing most strongly. These two processes seem to be separable, at least by observing the effects of different factors, but in reality they interact in a number of ways. Because our focus is on vocabulary effects on comprehension, these higher level interactions will not be discussed here.

In these five studies using three different passages, vocabulary knowledge and prior knowledge appear to have independent effects. Further, vocabulary knowledge appears to have effects on those measures that seem to involve the construction of a microstructure involving the relations between individual propositions in a text--a sentence verification task (Freebody & Anderson, 1983b; Stahl & Jacobson, 1986), recall of the order of events (Stahl et al., 1989, Studies 1 & 3), exact replacement of function words in a cloze task (Stahl et al., 1989, Study 2), and the number of propositions recalled (Stahl et al., 1989, Stahl et al., 1990), especially the number of details recalled (Stahl et al., 1990).

Prior knowledge also affected the recall of central and supporting propositions in the Stahl et al. (1989) and in the Stahl et al. (1990) study. Prior knowledge also had unique effects on measures of gist comprehension, or comprehension of the relative importance of information, such as a summarization task (Freebody & Anderson, 1983b), construction of a gist statement in recall (Stahl et al., 1990), and an importance rating task (Stahl, et al., 1989, Study 3). In the last three cases, however, these effects were relatively small. Further, the tendency of subjects to give irrelevant preteaching to recall facts that matched that preteaching in the Stahl et al. (1989) study and for subjects who claim more interest in the topic of baseball to recall more numbers in the Stahl et al. (1990) study suggests that differences in prior knowledge can also direct readers' attention to different information within the text (Reynolds & Anderson, 1982; Reynolds, Standiford, & Anderson, 1979).

How Vocabulary Difficulty Might Affect Microprocessing

When a reader encounters an unknown word, he or she seems to have two possible strategies available. The reader may decide to invest cognitive effort in discovering the meaning of the unknown word. This might involve a resource-intensive examination of the context. This is the presumption of researchers who have attempted to train students in the deliberate use of context to determine the meanings of unknown words. Training of explicit use of context cues does not seem to be overwhelmingly successful (see Graves, 1986, for review). In natural reading situations, readers are unlikely to devote limited resources to deriving word meanings from context. Instead, they are likely to take what limited information is available from the automatic use of context and proceed with reading. If so, they are likely to use an incomplete representation of the proposition containing the unknown word in the microstructure.

Omanson, Beck, McKeown, & Perfetti (1984) tested these two models using data from their training studies. They examined the recall protocols taken from subjects recalling passages containing 11% unfamiliar words. They presumed that if subjects would use context to derive the meaning of the unknown word, the resulting proposition would contain a rough synonym for the unknown word and would be otherwise processed normally. If the subjects formed an incomplete proposition, they would process the proposition only once, when it was encountered, and that proposition would be less likely to be recalled than it would be if all the words were familiar. They found that the second model, in which the unknown word was processed incompletely, better characterized their data than a model in which synonyms were substituted for unknown words.

Yet, their study may overstate the effects of lack of vocabulary knowledge. The target passages contained a very high amount of unknown words. Assuming that about half of the words in a typical passage are function words, the 11% of the total words in Omanson et al.'s (1984) analysis represents close to 25% of the content words of the passage.

It is unclear what percentage of unknown words is needed to disrupt comprehension. In the Stahl et al. (1989) study significant effects were found with a substitution of one out of six content words. However, Freebody and Anderson (1983a) found a one to three ratio was necessary to significantly disrupt comprehension. In any case, the passage used by Omanson et al. (1984) contained a fairly high percentage of unknown words. This high a percentage may have disrupted comprehension to a point that information was not available from context. Without the information available from ongoing comprehension, readers may have had no choice but to use incomplete representations. Whether they would do so with more realistic proportions of unknown words has yet to be demonstrated.

These models, of course, concern totally unknown words. In reality, most unfamiliar words are not totally unknown. Instead, they might be in a "twilight zone" in which the reader has some information about their meaning, but not full enough meaning to express it in a definition or use it productively and confidently in a sentence. Curtis (1987) has found that readers do not need this full knowledge to answer multiple choice questions typical of a vocabulary test. As the analysis above suggests, they also might not need such knowledge in typical comprehension activities. Instead, more general recognition of the word and a notion of what semantic domain it belongs to may to be enough for a word not to interfere with comprehension, depending on the importance of the word within the passage and the overlap and richness of the context.

Shore et al. (1987) found that "twilight zone" words were easier to learn than totally unknown words. This was especially true if the words were presented organized by semantic fields.

How Vocabulary Difficulty Might Affect Macroprocessing

While the studies cited above found that vocabulary difficulty largely affected development of a microstructure, words in those studies were chosen to be general terms, usable in a side variety of contexts. Other words tend to be associated with a restricted range of semantic fields, such as *tributary* for "river systems" or *capillary* for "circulatory system" or *bunt* with "baseball." In these cases, acquisition of word meanings seems to be inseparably connected with acquisition of knowledge in the semantic field. Knowledge of the word *capillary* might mark an individual as more highly knowledgeable about a subject matter. Stahl et al. (1990) found that subjects who knew more baseball terms, such as *bunt*, *shortstop*, and so forth tended to be more knowledgeable about baseball and that this knowledge affected their comprehension.

Encountering a term, such as *bunt* or *tributary* or *capillary*, would, at least for a reader with knowledge in the corresponding semantic fields, activate that knowledge. Activation of appropriate knowledge has been found to improve comprehension if the knowledge is focused on the concepts central to understanding the passage (Stahl et al., 1989). However, such activation may be inappropriate if the concepts are tangential to understanding. In that case, activation of knowledge may lead the reader to make bridging inferences between the semantic domain implied by the term and the actual intended meaning of the passage. If these inferences are inappropriate, comprehension will suffer. This may be one reason why metaphorical passages are difficult to understand.

Implications for Vocabulary Instruction

The view of the effects of vocabulary difficulty on comprehension from the word level taken here suggests that the effects that an individual unknown or partially known word would have on comprehension will depend on a number of different factors. An unknown word will be more likely to impair comprehension if (a) there is a relatively small overlap between information in the context and the word's meaning, (b) if the context is relatively sparse in information, (c) if the word is relatively important to the text, and/or (d) if the word represents a complex concept new to the reader. In addition, if children have less vocabulary knowledge, they are less able to take advantage of the overlap and richness of the information in the context, for both comprehension and learning word meanings from context. Finally, vocabulary difficulty is more likely to impair comprehension if the task is one involving microprocessing, such as recalling details from a text, than if the task involves macroprocessing, such as getting just the gist of the message. Conversely, if there is a wide overlap, with a rich context, the word is relatively unimportant, and so on, vocabulary difficulty will be less likely to impair comprehension. By itself, a difficult word will have little effect on comprehension.

Why Has Only Extensive Vocabulary Instruction Improved Comprehension?

If the purpose of vocabulary instruction is to provide enough knowledge for a reader to comprehend a passage containing a taught word, from the analysis thus far it would seem that how much knowledge is required depends on the word's context and on the comprehension task. Full knowledge may be necessary for certain comprehension tasks, such as metaphor (see Readence, Baldwin, Rickelman, & Miller, 1986), but in most cases, partial knowledge combined with information incoming from the context processor is sufficient. Some authors (e.g. Kameenui, Dixon, & Carnine, 1987) have argued that for most circumstances, relatively brief vocabulary instruction is all that is needed to teach words well enough for comprehension. In the *micturition* and *minatory* cases, a simple definition appears to be enough for comprehension to continue. Yet the research consistently shows that full and elaborate methods are necessary to improve comprehension.

One way of explaining this contradiction is to look at the comprehension tasks used to measure the effects of vocabulary instruction. As noted earlier, the majority of studies that found an effect for vocabulary instruction on comprehension used passages that contained high percentages of unknown words. Yet a high percentage of

unknown words may distort the effects of word knowledge by making the task of reading excessively difficult. If too many words are unknown, this may interfere with the feedback between the meaning processor and the context processor, making comprehension beyond the simplest level impossible.

In the case of comprehension breakdown, readers may take information from their prior knowledge to construct what they can from the text. In the studies cited above, this can be a gist statement ("This passage is about . . . ."). Yet enough word meanings are usually known to avoid comprehension breakdown. Instead, ongoing comprehension continually adds and acts on information available in the context processor. An unknown word might impair comprehension somewhat, especially of the proposition in which it is located, but information from context should enable ongoing comprehension, at least in a typical case of one and a half to three unknown words per hundred. The conundrum for the researcher interested in the effects of vocabulary instruction or vocabulary difficulty on comprehension is that, on one hand, one needs to have a certain percentage of unknown words in a target passage to overcome the beneficial effects from context, but, on the other hand, with too large a percentage of unknown words, the process observed may be markedly different than that which usually occurs.

It has been argued however that one needs to use passages with a high density of unknown words in order to gauge the effects of long-term vocabulary instruction (e.g. Stahl, 1983). Over the long term, a great many words would have been taught and a passage containing these words might look like those used in the studies cited above. This argument has merit. Indeed, using such contrived passages may be the only way of demonstrating that vocabulary instruction affects comprehension. Yet one must be aware of the limitations of such use.

How Extensive Does Instruction Have to Be?

Many of the same factors used to analyze context, word, and reader differences in the effects of vocabulary knowledge on comprehension can be used in deciding how intensive or extensive instruction needs to be. Many of the approaches discussed in the literature for teaching word meanings assume, explicitly or implicitly, that a reader needs to have full knowledge of a word's meaning to comprehend it in text. Indeed, providing full knowledge is the only way of improving comprehension in a text with 10% of the words unknown. Given a certain degree of support from context, instruction need only provide partial knowledge, or instruction may not be needed.

How is one to decide whether or not instruction is needed, or how extensive that instruction should be? Many of the factors discussed here could be part of that decision-making process. First, if a word represents a concept that is new to a child, that is, a concept that the child does not already have experience with or know any other words for, this word will require extensive instruction. This instruction might include providing examples and non-examples of the concept, giving superordinate and subordinate terms, and so on, possibly including concrete experiences (for one approach, see Frayer et al., 1969; also Wixson, 1986).

If a word represents a known concept, then one should examine the context in which it is set. If the proposition the word is in is relatively important, then the word should receive more extensive attention, even if the context is relatively directive. Wixson (1986) tested this hypothesis directly, finding that students instructed on words contained in propositions central to the story answered correctly significantly more questions about that central information than students instructed on words located in noncentral propositions. Students instructed on words located in noncentral propositions gave fewer correct answers about central information and more correct answers about noncentral information, suggesting that vocabulary instruction can misdirect a students' comprehension as well as direct it. If a word is relatively unimportant to the passage, teaching it might increase students' attention to that unimportant information.

If the context is relatively directive (that is, there is a strong overlap between the information in the context and the word's meaning and the information is relatively rich), then again the word might not need to be taught, since the context may provide enough information without such instruction. However, it should be cautioned that students with low vocabulary knowledge might not be able to take advantage of a rich context if they do not

know the meanings of surrounding words as well. These students might especially require specific instruction in word meanings.

This analysis, therefore, suggests that extensive instruction is required (a) if the concept represented by the word is not known by the student, (b) if the proposition the word is in is relatively important, and (c) if the context is nondirective or misdirective. Instruction might not be needed if the proposition containing the word is relatively unimportant and the context is relatively directive. In between these extremes, words need more or less extensive instruction.

What do we mean by more or less extensive instruction? In the rich and extensive instruction given by Beck and her colleagues (e.g. Beck, et al., 1982), an average of 17 minutes of instruction was provided per word taught, including drill on definitions, discussion of whether the word would fit into a particular sentence context, having students generate their own contexts, and so on. Such instruction produced powerful effects on their comprehension measures.

Less extensive instruction might consist minimally of providing a definition orally and discussing one or two sentences for each taught word. One such minimal approach, "Possible Sentences," involves providing a list of target and known words, briefly discussing the target words, and having students generate sentences that possibly could be in the text they are about to read that contain at least two of the words on the list. After reading, students discuss whether the sentences could or could not appear in the text. Such an approach produced significant effects on recall of facts in science material in two separate studies (Stahl & Kapinus, 1990).

There is evidence, however, that definitional drills, a traditional model of vocabulary instruction, are not effective. For example, Jenkins, Pany, and Schreck (1978) found that drilling children on definitions failed to improve comprehension on a number of measures. This may be because, as discussed earlier, readers do not merely substitute a synonym when meeting a newly learned word. Instead, they bring to bear information from a number of previously encountered contexts. Even the most abbreviated vocabulary instruction should include both definitional and contextual information.

Approaches to vocabulary instruction that have been found to improve comprehension have exposed students to a breadth of information about each words' meaning, not just a synonym or definition (see Stahl & Fairbanks, 1986). In addition, effective approaches must provide students with a number of different exposures to words in different contexts. Such different exposures allow a reader to have a number of different connections to other known words, as well as a sense about which of these connections are the most salient. To be useful, vocabulary knowledge needs to be flexible. Nitsch (1978) found that children who learned word meanings in one context were very adept at understanding those words only in the contexts in which they were learned. Children who saw the words in multiple types of contexts were better able to recognize the words in novel settings.

Nagy (1988) has argued that all of these conditions can be satisfied through learning from context. Indeed, they can be, and most vocabulary is learned from context and learned apparently well enough. As Carroll (1964) pointed out, good vocabulary instruction should mimic the effects of context learning, except it should do so more efficiently.

Four Hypotheses

This report began with the hypotheses engendered by Anderson and Freebody's (1981) seminal paper on vocabulary knowledge. This review suggests that the "truth" captured by each of these hypotheses depends on the particular contexts in which a word is found, the way the task of comprehension is defined, and the amount and types of knowledge a person has about a word. It is possible within the literature to find support for each hypothesis and to find situations where each is irrelevant.

In the explosion of research since the Anderson and Freebody (1981) paper, we have resolved some of what might be called "first generation" questions about vocabulary knowledge and its effects on reading comprehension.

We have also found that it is necessary to move beyond these initial hypotheses, and to begin to examine the conditions in which a person's knowledge of word meanings influences comprehension (microprocessing or macroprocessing) in different contexts (directive to misdirective, important to unimportant). Much of this report is speculative, but it is speculation intended to be useful in defining a next step for vocabulary research.

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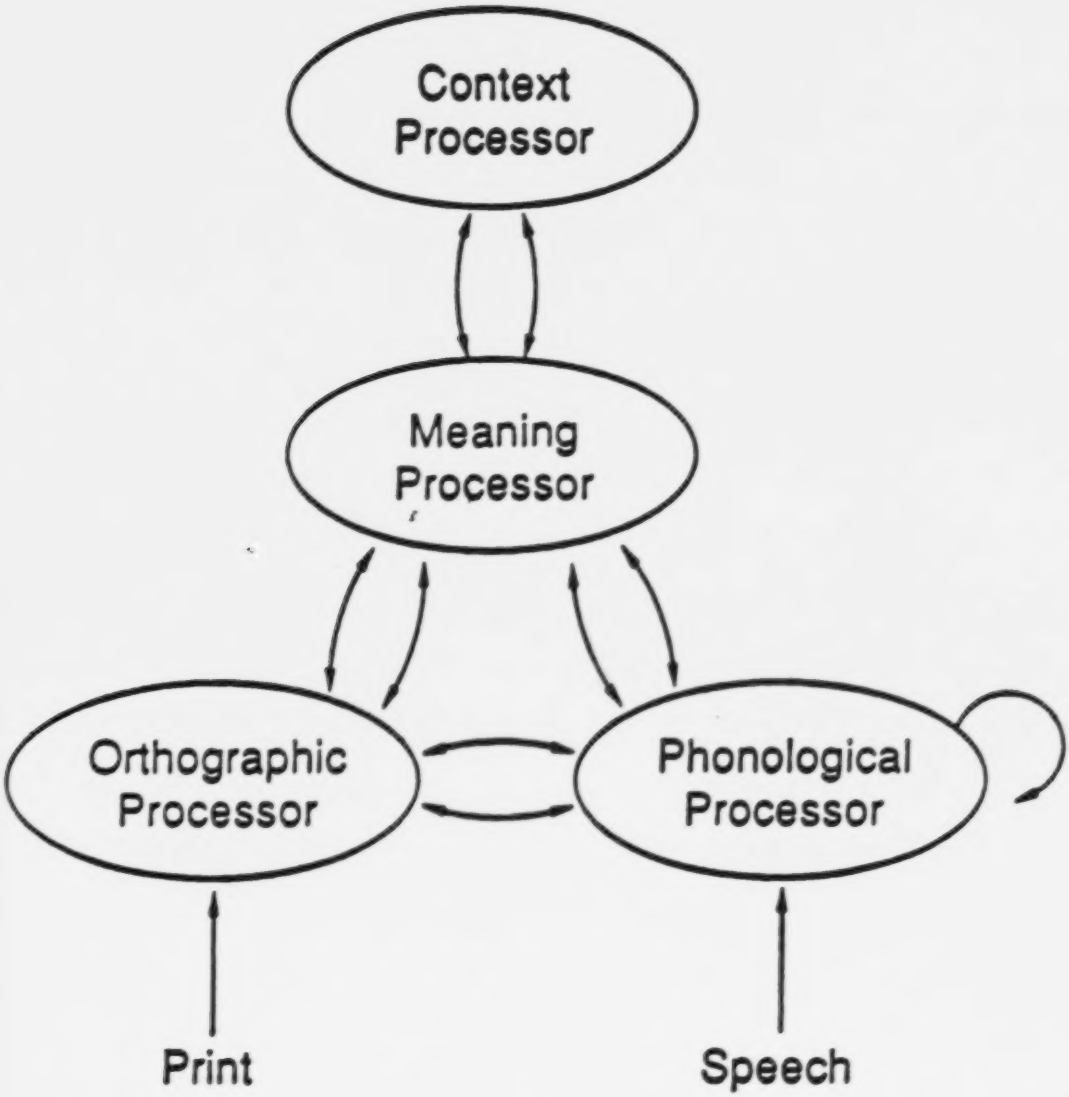
Context Processor
Meaning Processor
Orthographic Processor
Phonological Processor
Print
Speech

Figure 1